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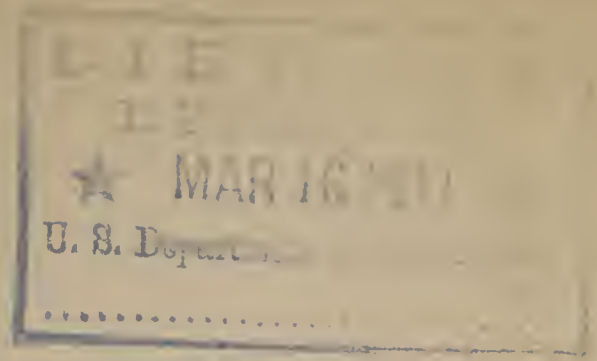


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U. S. DEPARTMENT OF AGRICULTURE,
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A. D. MELVIN, CHIEF OF BUREAU.

MEDICAL MILK COMMISSIONS AND BOVINE TUBERCULOSIS.

BY

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MEDICAL MILK COMMISSIONS AND BOVINE TUBERCULOSIS.^a

By E. C. SCHROEDER,
Superintendent of Experiment Station.

INTRODUCTION.

The primary object of a medical milk commission, unless I am in error, is to discover and to define the conditions that must govern the production and the distribution of milk to insure that it shall reach the consumer, not occasionally or even generally, but constantly, as a fresh, clean, and wholesome article of food, and, above all else, as an article of food certainly free from any virus that may injure human health. In accordance with this view it is really unnecessary for a milk commission to know the precise significance of bovine tuberculosis with regard to public health, or to determine whether tuberculosis of persons and cattle is caused by identical or by dissimilar types of bacilli. What a milk commission must know is whether tuberculous cattle expel tubercle bacilli that can injure human health, and whether such bacilli occur in milk obtained from tuberculous dairy herds. The title of this paper therefore requires the consideration of two subjects: First, the susceptibility of persons to bovine types of tubercle bacilli; and, second, the occurrence of tubercle bacilli in milk.

THE SUSCEPTIBILITY OF PERSONS TO BOVINE TUBERCLE BACILLI.

No valid reason existed for doubting that the introduction of tubercle bacilli into the human body, equally from the human and the bovine source, was dangerous until Theobald Smith demonstrated that the bacilli more commonly found in human tuberculous lesions are not exactly like those commonly found in bovine tuberculous lesions. The importance of Smith's work was not fully recognized until Koch used it, together with a number of unsuccessful attempts, made in conjunction with Schütz, to infect cattle with tubercle bacilli from the human source, as the foundation for the broad generalization that "human and bovine tuberculosis are not alike and that the latter is of negligible importance for public health."

^a This paper was presented before the American Association of Medical Milk Commissions at St. Louis, Mo., June 6, 1910.

If we take into consideration that Smith discovered the difference between the types of tubercle bacilli designated as human and bovine, and that Koch is the first and most authoritative among those investigators who have used the discovery as the basis for the assertion that persons are practically immune against tubercle bacilli of the bovine type, then, if it can be shown that Smith supplies evidence of the kind demanded by Koch to prove that persons are susceptible, and fatally susceptible, to tubercle bacilli of the bovine type, we may feel assured that we will not go astray if we conclude that bovine tubercle bacilli from the bovine source must be looked upon as a virus to which public health can not be exposed with impunity.

Koch has stated repeatedly that the isolation of tubercle bacilli of the bovine type from human tuberculous lesions, under strict conditions that exclude errors, is acceptable proof that the source of infection was bovine; and Smith, whose ability to distinguish without error between different types of tubercle bacilli no one can question, isolated bovine types of tubercle bacilli from human lesions with sufficient frequency to lead him to make the following statement in Washington during the International Congress on Tuberculosis in 1908:

A rough and liberal estimate would make from one-fourth to half the cases of tuberculosis starting in the cervical and mesenteric lymph nodes bovine in origin. This estimate, to which many have contributed, has placed our knowledge concerning the infection of man from cattle on a firm basis.

Strictly speaking, there is no need to go beyond this to prove that a medical milk commission must regard the presence of bovine tubercle bacilli in milk as a positively objectionable and seriously dangerous condition, but it may nevertheless be well to give the subject a little more attention.

Woodhead, of the British Royal Commission on Human and Animal Tuberculosis, apparently holds views similar to those of Smith on the relationship between primary lesions of tuberculosis and the proportion of tuberculous infections chargeable to the bovine source. In a lecture, recently published in the *Medical Record*, he called attention to the fact that observers, including those working on the German Imperial Tuberculosis Commission, seem to agree that we have a definite and frequent tuberculous affection of the alimentary canal among children, and that of these cases a certain proportion is undoubtedly of bovine origin. He further called attention to the fact that, of the fatal cases of tuberculosis among children investigated by the German and British tuberculosis commissions, about one-third were found to be due to the bovine type of bacillus. Taking these facts into account with the frequency of tuberculosis of the alimentary canal among children under 5 years of age, as shown by autopsy records in Great Britain, Woodhead concluded that a little

less than 7 per cent of the total deaths from tuberculosis in Great Britain are due to the bovine source of tubercle bacilli.

Primary tuberculosis of the alimentary canal is seemingly commoner in Great Britain than in America, hence an estimate for our country similar to that of Woodhead, but corrected to conform with the frequency of alimentary tuberculosis in America, will charge a much lower proportion of tuberculous deaths to bovine infection, approximately $1\frac{1}{2}$ to 2 per cent of the total number. This proportion is very well supported by the evidence obtained from American investigators who have made special studies of the types of bacilli currently found in human tuberculous lesions, and also by the general statistics on fatal tuberculosis in the United States. The latter show with a fair degree of constancy that about 87 per cent of all deaths from tuberculosis are due to the pulmonary form, and about 13 per cent to other forms of the disease. Of the 13 per cent about one-quarter, that is, $3\frac{1}{4}$ per cent of the total deaths, are true cases of abdominal tuberculosis.

This estimate is the lowest that can reasonably be entertained, in the light of the facts as we know them to-day, of the harm done to public health by the bovine source of tuberculosis; it is an estimate that can not be lowered without trying to outstrip Koch in his attempts to belittle the significance of bovine tuberculosis as a source of human disease, and yet it is an estimate which means that from 2,400 to 3,200 deaths are caused annually in this country, principally among children, by bovine tubercle bacilli.

To remove all possible doubt about the lowness of the estimate, and to show that it is probably much too low—though it is large enough to justify the condemnation of all raw dairy products not above the suspicion that they may contain bovine tubercle bacilli—I wish specially to emphasize that it is based wholly on data characterized as satisfactory by those investigators whose authority, more truly than substantial and convincing proof, originated the controversy regarding the identity of human and bovine tuberculosis, and who have tried most diligently to prove that the bovine source of tuberculosis has no terrors for mankind.

Attention should also be called to the fact that the estimate wholly ignores the excellent investigations that give us reasons to believe that strains of tubercle bacilli are not constant in their types and virulence; that it makes no allowance for the actual discovery in tuberculous lesions of tubercle bacilli that are intermediate and possible transition forms between the human and the bovine; that it does not take into consideration that even fatal cases of pulmonary tuberculosis may be due to infection through the alimentary canal; and that it does not magnify itself by borrowing strength from significant data like the following: That tubercle bacilli may remain latent in animal tissues for long periods of time; that bovine types of bacilli

are isolated with an enormously greater frequency from the tuberculous lesions of children than from those of adults, and that the latency of tubercle bacilli on one hand, and the greater frequency of bovine types in the lesions of children on the other hand, are conditions which, when taken together with the type mutability of tubercle bacilli and the occurrence of intermediate types in human lesions, strongly suggest that the occurrence of human types of tubercle bacilli in the tuberculous lesions of adults does not give us an unimpeachable argument to reject tuberculous cattle as the source from which the infecting agent was originally derived, particularly when we deal with chronic tuberculosis, pulmonary cases included.

Furthermore, the estimate deals only with fatal cases of tuberculosis, and this is of the utmost importance, because a medical milk commission, as a matter of plain duty, must fight against milk-borne diseases irrespective of their probable end in recovery or death.

If the human body is more resistant to bovine than to human types of tubercle bacilli, or if bovine types have a lower pathogenic virulence than human types for the human body, which is practically the same thing, and deaths occur among persons who are infected with bovine types of tubercle bacilli and recoveries among those who are infected with human types, both of which we know to be the case, we may logically conclude that the number of recoveries in proportion to the number of deaths will be greater among the persons who are infected from the bovine than among those who are infected from the human source of tuberculosis. I believe that I simply state a truism when I say that the ratio between the recoveries and deaths from an infectious disease is in close harmony, other things being equal, with the immediate pathogenic virulence of the infecting agent. From this point of view, if bovine types of tubercle bacilli are, contrary to their virulence for all other species of animals, of lower virulence for the human species than human types, they must be charged with causing a large amount of disease that does not reach a fatal climax, and hence, with being common handicapping factors in the physical and mental development of children. It is well to bear in mind when we think of this that tuberculosis, though it causes more than 10 per cent of all deaths, is a disease that has been proven by modern methods of diagnosis and careful post-mortem examinations to be greatly more prevalent than we formerly believed it to be, and that cases of arrested and spontaneously healed tuberculosis are much more numerous than those that die.

Enough has been said to show conclusively that we should make a strong and unremitting fight against the exposure of public health to bovine tuberculosis, especially for the protection of children. Enough has also been said to show that we need not use insufficiently confirmed experimental evidence, of a kind we can not afford to ignore altogether and which justifies the belief that bovine tubercu-

losis is a very serious public health danger, to prove that it is imperatively necessary for every milk commission to demand that milk shall be produced under conditions which will exclude all types of tubercle bacilli from it, or that it shall be subjected to some treatment which will make tubercle bacilli harmless before it is used as food. Hence, the second part of the subject will be taken up.

THE OCCURRENCE OF TUBERCLE BACILLI IN MILK.

Many tests have been made during the last three or four years concerning the occurrence of active, virulent tubercle bacilli in milk. These tests have shown (1) that a large quantity of milk infected with tubercle bacilli is distributed by dealers to their customers; (2) that the occurrence of tubercle bacilli in the milk distributed by different dealers who sell infected milk is more commonly intermittent than continuous; and (3) that it is not only ordinary market milk that contains live tubercle bacilli, but that they also occur in some of the so-called commercially pasteurized milk.

That much of the ordinary milk of commerce contains live, virulent tubercle bacilli (more than 5 per cent of all the samples recently examined of which the writer has been able to get the records) must be looked upon as a regrettable and serious condition, not alone because we know that it is the real, responsible cause for much disease and the destruction of several thousand or more children every year in our country, but also because many investigators and observers are strongly of the opinion that infection with tuberculosis depends in the great majority of instances on frequently repeated introductions of tubercle bacilli into the body, and rarely on a single or an occasional exposure to tubercle bacilli; and because some investigators of the highest order have supplied us with reasons to believe that the introduction of tubercle bacilli into the body, even though they are of a kind or type that is incapable of causing a progressive or fatal tuberculosis, is responsible for a negative state of resistance, of longer or shorter duration, to infection with subsequently introduced tubercle bacilli. In other words, each successive exposure to tubercle bacilli seems to be more dangerous than previous exposures, and this as a direct result of the previous exposures. While this view is admittedly hypothetical, it is worth while to keep it in mind when we study the possible influence the numerous tubercle bacilli from the bovine source that are swallowed with raw dairy products may have in preparing our bodies for the growth within it of tubercle bacilli of any type or kind.

The intermittent occurrence of tubercle bacilli in the milk distributed by individual dealers signifies that the extent to which the public is exposed to infection through the use of raw dairy products can not be measured by knowing only the percentage of milk that contains tubercle bacilli, because the proportion of dealers who distribute

infected milk more or less intermittently has an important bearing on the number of persons who are exposed to infected milk. For example, Professor Eber, of the University of Leipzig, in Germany, examined the milk sold by 70 dealers at three different times. Among the 210 samples of milk examined, 3 from each dealer, 22 were found to contain tubercle bacilli. When the infected milk was charged to the dealers who sold it, Professor Eber found that one dealer sold 3 samples, another 2, and that the remaining 17 samples were sold by 17 different dealers; hence, though only 10.47 per cent of the total number of milk samples examined were found to be infected, the persons who were buying milk from 19, or 27.1 per cent, of the milk dealers were exposed to tuberculous milk.

The conditions in our country relative to the intermittently infected character of the milk sold by different dealers are similar to what Professor Eber found in Germany. This can be determined by analyzing the milk tests recorded by Anderson, of the United States Public Health and Marine-Hospital Service, in Bulletin 56 of the Hygienic Laboratory. In one of the writer's own series of tests 31 samples of milk were examined, each taken on a different day, from one and the same dealer, and it was found that 4, or 13 per cent, and not all the samples, contained tubercle bacilli. Had Eber continued to make series of tests with the milk sold by the 70 dealers included in his investigation of the milk supply of Leipzig, it is probable that he would have found no great variation in the percentage of infected samples, but that the percentage of dealers selling infected milk would have climbed rapidly upward to a very high maximum.

The manner in which tubercle bacilli are expelled from the bodies of tuberculous cows, frequently long before symptoms of disease can be detected, the frequent occurrence of tuberculosis among dairy cattle, the percentage of milk that contains tubercle bacilli, and the intermittent character of the infected condition of the milk sold by dealers, are facts that should convince us that we can not expect milk to be constantly free from tubercle bacilli unless it is obtained from healthy cows in an environment that is free from tuberculous infection.

The question may present itself here, Why does not the common occurrence of tubercle bacilli in milk cause the infection of the entire human race? In this connection it is well to remember that the human race is actually rather badly infected with tuberculosis, if the information derived from tuberculin tests and autopsy records is not grossly misleading, and that infection with tuberculosis does not always manifest itself in the form of physically determinable and observably progressive disease. Fortunately in most cases various incidents must fall together with the presence of tubercle bacilli in the body to cause an actively progressive tuberculosis, and a great danger from infected milk is that children are so persistently and

helplessly exposed to it that many of them can hardly escape swallowing tubercle bacilli at times when the germs will meet those conditions in their bodies with which they can form more or less injurious and at times fatally destructive combinations.

The occurrence of living tubercle bacilli in so-called commercially pasteurized milk must not be charged against the efficiency of pasteurization as a method for destroying disease germs in milk. It is merely evidence to prove that pasteurization as sometimes practiced for commercial purposes is not safe, and that, to be thoroughly reliable, the pasteurization of milk, if it is done before the milk is delivered to the consumer, should be conducted under strict official supervision.

The following may be interesting to show how reliable pasteurization is when it is properly done in a simple, economical way that can be practiced in any kitchen. In a special investigation at the Experiment Station of the Bureau of Animal Industry the writer gave an employee—not a trained scientist, but an intelligent laborer—instructions to divide the milk of a cow affected with tuberculosis of the udder into two lots each day, and to pasteurize one lot and to leave the other lot in its raw, untreated condition. This work was repeated with the milk of the cow daily for more than a month, and on each day guinea pigs were injected, some with the pasteurized and some with the raw milk. The method of pasteurization used was simply to place the milk in cotton-stoppered bottles, in which it was rapidly brought to a temperature of 60° C. (140° F.) by immersing the bottles in hot water. The elevated temperature was maintained twenty minutes, and the milk was then rapidly cooled by immersing the bottles in cold water. The special investigation in hand required that I should know that I was dealing with the nearest possible article to raw, fresh milk naturally contaminated with tubercle bacilli that had been killed; hence the guinea pigs were injected, those with raw milk to show that the milk certainly contained tubercle bacilli, and those with pasteurized milk to show that the tubercle bacilli had certainly been killed. The total number of guinea pigs injected with each kind of milk was over 100. The injections were made into the peritoneal cavities, this method being one of the most delicate tests that we have for tubercle bacilli. Among the guinea pigs injected with the raw milk 98 per cent contracted generalized tuberculosis; among those injected with the pasteurized milk not one showed a single lesion of disease.

A more conclusive demonstration of the efficiency of low temperature pasteurization (60° C. or 140° F.) maintained for twenty minutes seems almost impossible. The temperature is 72° F. below the boiling point of water and only 41.5° F. above the normal temperature of the human body, which latter has a temperature several degrees lower than the body of a healthy milch cow.

CONCLUSIONS.

The evidence we have to prove that tubercle bacilli derived from cattle cause tuberculosis—and fatal tuberculosis—among human beings is direct and irrefutable. The evidence we have to prove that the milk from tuberculous dairy herds frequently contains living virulent tubercle bacilli is equally direct and irrefutable. Hence, no medical milk commission should consent to the certification of milk unless it is obtained from cows that are free from tuberculosis and that are kept in an environment free from tuberculous infection.

As medical milk commissions can not reasonably restrict their good work to a rare article, such as certified milk is and must remain for a long time to come, they should recommend some measures for the immediate protection of the milk-using public generally. The simplest, the least expensive, and the most efficient available expedient through which the public can be protected against bovine tubercle bacilli and other viruses that may be disseminated with milk is pasteurization. Hence, pasteurization should be recommended for all milk that is not certainly free from the germs of tuberculosis or those of other diseases.

As ordinary commercially pasteurized milk has been proven to be unreliable, by the discovery of live tubercle bacilli in it, medical milk commissions should insist on strict official supervision for all pasteurization of milk that is practiced elsewhere than in the home of the consumer. Until official supervision is established, we should teach that home pasteurization rather than commercial pasteurization is a true protection against milk-borne agents of disease.

It is not meant by this that all commercial pasteurization is unsatisfactory, because the contrary is known to be true. But for the general consumer of milk to distinguish between properly pasteurized milk and milk pasteurized only for commercial purposes is not far from impossible; and therefore, until commercial pasteurization has been placed under official supervision, home pasteurization seems to be the best solution.

The availability, efficiency, and low cost of pasteurization should not be regarded as reasons for relaxing the efforts that have been made, and that are being made, through inspection, education, and otherwise, to improve the general milk supply.

Finally, it may be added that the low estimate of the harm done by bovine tubercle bacilli given in this paper is far below what the writer and many others believe to be true. I hold the opinion now, and have always held it, that the human source of tubercle bacilli is responsible for a much larger proportion of human tuberculosis than the bovine source; but I am thoroughly convinced that there is no equal number of cases of tuberculosis, among all those that are caused by the infection of persons with tubercle bacilli expelled by persons, that can be prevented as easily, as cheaply, and as certainly as the numerous cases that are due to the infection of persons with tubercle bacilli derived from the bodies of tuberculous cattle.

